Clinical Update

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Managing the Missing Papilla: Challenges, Options, and Expectations

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Introduction

An esthetic smile relies upon a pleasing balance of color and shape of ideal tooth and gingival tissue proportions.[1] The unfilled gingival embrasure space of inadequate or absent papillae can present as a dark triangle leading to poor esthetics and functional deficits in phonetics or mastication. Treatment options for restoring lost papillae are driven by the etiologic factors contributing to the altered tissue appearance and can prove extremely challenging with limited outcome predictability. This clinical update will review the structure of the papilla, present papilla management and treatment guidelines, and suggest ways to help direct patient expectations.

Anatomy of the Papilla

The interdental papilla is a three-dimensional pyramidal soft tissue structure within the gingival embrasure space, extending from the bony crest towards the interproximal contact. The core is comprised of connective tissue attached to the underlying alveolus and supported by dentogingival and interpapillary collagen fibers.[2,3] Keratinized squamous epithelium covers the buccal and lingual outer surfaces of the papilla, while nonkeratinized sulcular and junctional epithelium line the tissue approximating the adjacent tooth surfaces.[2] The blood supply is limited to a small capillary plexus arising from terminal branches of alveolar arteries originating from the underlying alveolus and adjacent periodontal ligament spaces.[4] The diminutive blood supply and unique gingival architecture contribute to the complexity of reconstruction of loss structure.

Etiology of Papillary Loss

When determining how to approach the absent papilla, the first step is identifying etiological factors. In health, complete papillary fill is not guaranteed and largely depends on the gingival embrasure dimensions. When the vertical distance from the crest to the interdental contact point is between three to five millimeters, papillary fill is anticipated nearly 100% of the time. However, as this vertical distance increases beyond five millimeters, the likelihood of papillary fill decreases markedly.[5] The interproximal distance also influences the presence of papillae. The predictability of a soft tissue-filled embrasure decreases as the interdental space widens beyond 1.5-2.5 mm.[6] Other anatomic factors related to papilla absence include root divergence, long-narrow or triangular teeth, short or absent proximal contacts, and thin interdental gingival tissue.[7,8,9]

The loss of an existing papilla may result from the natural aging phenomenon or, more commonly, from periodontal trauma or pathology.[2] Trauma may be introduced via overly aggressive hygiene techniques, factitious habits, or restorations. A significant challenge for the clinician is the loss of the papilla due to disease. Periodontitis results in interdental bone loss, increasing the distance from crest to contact, and may lead to pathologic tooth migration,[10] altering embrasure shapes and reducing anatomic favorability for papillary fill. Papillae loss is also a cardinal sign of necrotizing periodontal diseases.[11] Unfortunately, periodontitis treatment may worsen papilla loss. Resolution of inflammation reduces tissue volume, and surgical intervention results in bone remodeling and fibrotic scar tissue formation. These factors can compromise the ideal space requirements of papillary fill and alter the delicate blood supply. With vascular compromise, regeneration becomes increasingly difficult. By recognizing these limitations, the astute clinician can better temper the expectations of even the most exacting patients.

Classification of Papilla Loss

Various classification schemes evaluating papilla loss have been proposed. The Nordland & Tarnow Classification (1998) focuses on the relationship of the papilla tip to the facial cervical enamel junction (CEJ), the interproximal CEJ, and the interdental contact point (Table 1).[12] The Papilla Presence Index (PPI), proposed by Cardaropoli et al, scores papilla loss by esthetic compromise and the presence of interproximal contact points (Table 2).[13] Increasing class or score represents heightened anatomic complication and complexity of restoration for both classifications.

Table 1. The Nordland and Tarnow Classification.[12]

Class	*Descriptor*
Normal	Interdental papilla fills embrasure to contact
Class I	Papilla tip lies between contact and interproximal CEJ
Class II	Papilla tip lies at/apical to interproximal CEJ but coronal to facial CEJ
Class III	Tip of papilla lies level with or apical to facial CEJ

Table 2. The Cardaropoli et al Papilla Presence Index.[13]

Score	*Descriptor*
1	Papilla completely present, same level as adjacent papilla
2	Papilla no longer completely present, tip lies apical to contact point, no longer equal to adjacent papilla, interproximal CEJ not visible
3	Papilla apical, interproximal CEJ visible; extensive interdental recession
4	Papilla apical to both interproximal and buccal CEJ, buccal and interproximal recession, dramatic esthetic compromise

Non-Surgical Management of the Papilla

Management of interproximal papilla loss typically does not require surgical intervention. Due to the limited predictability of surgical augmentation, various non-surgical multidisciplinary interventions can be utilized alone or in combination with surgery to manage disease and create more favorable interproximal anatomy.

Non-Surgical Periodontal Therapy

Papilla loss related to gingival disease from overzealous hygiene practices or factitious habits first requires correction of the offending etiology. Initial non-surgical therapy and behavior modification may allow for re-epithelialization of the tissue structure, which can resolve papilla loss. One study reported the re-establishment of interproximal tissues by intentionally inducing a hyperplastic healing response from periodic curettage performed every ten days for 40 days.[14] During the nine month follow up period, papilla fill returned for some subjects. However, the results were not widely predictable.[14]

Restorative Therapy

When poor crown form, short or missing contacts are contributing factors to the lack of an interdental papilla, a restorative approach to create favorable anatomic embrasures for papilla fill is indicated. Placing the interproximal contact more apically and adjusting the gingival contours of a restoration can encourage an apical creeping phenomenon of the interdental tissues into the embrasure space.[2] This approach is technically demanding and requires careful attention to ensure that existing interdental soft tissues are not traumatized during restorative preparation.

Orthodontic Therapy

Orthodontic therapy may be considered when tooth position, angulation, and interproximal bone loss cause papillary loss. Orthodontic bodily movement and uprighting distally angulated roots can create an ideal embrasure.[7] In cases of interproximal bone loss, controlled, low-force orthodontic extrusion at a rate of one mm per month has also been demonstrated to induce coronal migration of papillae.[15] However, orthodontic treatment should *never* be initiated in the presence of active periodontal inflammation, and all signs of active periodontal disease must be resolved first. Extrusion is an option for papillary regeneration in cases where it will not compromise crown-to-root ratio or when used before hopeless tooth extraction for ridge development and future implant placement.[15]

Surgical Management of the Reduced Papilla

Multiple surgical methods have been proposed in an effort to reconstruct deficient papillae adjacent to both teeth and dental implants. The least invasive of these methods uses injectable materials to augment the papillary tissue volume. Hyaluronic acid, autologous fibroblasts, and engineered stem cells have been reported in case studies to increase the volume of interdental tissues and reduce the appearance of black triangles. However, the stability of these results beyond six months is limited, with only a modest 41% improvement in interdental papilla fill.[16]

Surgical soft tissue procedures have also been reported with varying results. The success of these augmentation methods largely depends on maintaining vascularity in the existing papilla as well as establishing vascularity in the grafted tissues. Han and Takei proposed creating a semilunar incision at the papilla base to raise and coronally position by insertion of a connective tissue graft (CTG).[17] Similar techniques using a combination of CTG and a full thickness tunnel that maintains the soft tissue blood supply while coronally positioning the papilla have demonstrated promising results for reestablishing vertical papilla height.[18] Techniques combining tunneling with a palatal pedicle CTG, preserving the blood supply from the existing interdental soft tissues and the grafted tissue, are also favorable.[19] Despite these reported successes, even the best outcomes only result in 60% reduction of black triangles, and complete regeneration is rare.[16] Successful surgical reconstruction of the interdental papilla is exceptionally technique sensitive and requires extreme diligence in case selection.

Preventing Surgically Induced Papilla Loss

Surgical treatment of periodontal disease may induce interdental attachment loss, resulting in reduced papilla fill. Therefore, in the esthetic zone, it is of utmost importance to utilize techniques that increase wound stability and decrease the likelihood of tissue loss. Frisch's anterior curtain technique, described in 1967, preserves soft tissue esthetics during resective procedures in the anterior maxilla. This technique advocates the use of a palatal approach, leaving the facial 2/3rd of the papilla and its blood supply intact.[20] With the evolution of regenerative procedures came the introduction of Takei's papilla preservation technique in 1985. This method utilizes a semilunar incision at the lingual papilla's outer surface, leaving the facial tissue and blood supply largely intact.[21] More recently, microsurgical methods have been developed, reducing the chance of tissue loss when treating interdental lesions in the esthetic zone, including the minimally invasive surgical technique (MIST) and modified MIST techniques, the soft tissue wall technique, and the modified vestibular incision subperiosteal tunnel access (VISTA) technique.[16] Although microsurgical techniques can improve esthetic outcomes when compared to traditional methods, these specialized techniques require expertise and precision.

Managing Patient Expectations

The key to interdental papilla management is establishing appropriate patient expectations of outcomes. Patients should be properly educated regarding the etiology of their papillary loss and the challenges regarding treatment to appreciate the limitations of surgical and restorative techniques. Surgical success relies not only upon the skill of the dental providers and careful case selection but also on the patient's ability to adequately manage their post-operative healing process and a commitment to maintenance.

Conclusions

A missing papilla can be detrimental to smile esthetics. Frequently resulting from a complex, multifactorial etiology, the lost papilla is best regained by a multidisciplinary approach. Surgical reconstruction of the lost papilla remains largely unpredictable and relies heavily upon case selection and surgical expertise. Clinicians must understand the etiology, available treatment options, and limitations for interdental papilla management to establish realistic patient expectations.

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